

國立成功大學
110學年度碩士班招生考試試題

編 號： 271

系 所： 生物化學暨分子生物學研究所

科 目： 分子生物學

日 期： 0203

節 次： 第 2 節

備 註： 不可使用計算機

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、(共 14 分，每題 2 分)

1. Which of the following statements about eukaryotic and prokaryotic RNA polymerases, is false?
 - A. There are 3 different RNA polymerases in eukaryotes, instead of just one.
 - B. Eukaryotic polymerases have the same number of subunits as prokaryotic ones.
 - C. Only prokaryotic polymerases use sigma factor.
 - D. The enzymatic mechanism is the same for both types of organisms.

2. Which enzyme transcribes genes encoding tRNA in eukaryotes?
 - A. RNA polymerase I
 - B. RNA polymerase II
 - C. RNA polymerase III
 - D. Different tRNAs are transcribed by different RNA polymerases.

3. Which of the following events serves as an inhibitory role in cell cycle progression?
 - A. Growth factor signaling
 - B. Synthesis of cyclins
 - C. Rb binding to transcription factor E2F
 - D. MDM2-mediated proteolysis of p53
 - E. Interrupted DNA damage signaling

4. Regarding regulation mechanism of bacterial DNA replication initiation, which of the following statements is "false"?
 - A. Methylation of origin regulates replication initiation, in which methylation on one of the DNA strands is sufficient to permit initiation.
 - B. Serving as the licensing factor, replication initiator DnaA must be made anew for each round of replication.
 - C. DnaB helicase by itself cannot open duplex DNA.
 - D. DNA gyrase relaxes DNA topological stress to help replication forks to proceed.
 - E. Delay methylation of origin helps to prevent premature reinitiation of replication.

5. Regarding DNA polymerases, which of the following statements is "false"?
 - A. They all synthesize DNA in 5'-to-3' direction.
 - B. They usually possess 3'-exonuclease activity for proofreading.
 - C. Processivity of DNA polymerization reduces the chance of framshifts.

- D. DNA polymerases serving as replicases usually form multisubunit holoenzymes, while those working in DNA repair normally function as independent enzymes.
 - E. Error-prone polymerases lack proofreading activity, enabling them to perform translesion replication.
6. Regarding enzymes/proteins involving in DNA replication, which of the following statements is “false”?
- A. Primase makes RNA primer to provide 3'-OH ends for DNA synthesis.
 - B. Single-stranded binding protein unwinds duplex DNA, providing single-stranded region for initiating lagging strand synthesis.
 - C. β clamp encloses, slides along duplex DNA, conferring processivity on DNA polymerase holoenzyme.
 - D. FEN1 recognizes and removes single-stranded flap, helping to resolve primers from nascent DNA.
 - E. Ligase seals nicks in nascent DNA.
7. Small molecule drugs targeting type II DNA topoisomerases serve as efficient antibiotics and anticancer drugs. Which of the following “facts” about these enzymes do you think is the main reason making them the ideal targets in combating bacteria and cancer cells?
- A. They are highly conserved across all organisms.
 - B. They are ubiquitously expressed in all kinds of cell/tissue.
 - C. They are responsible for solving DNA supercoils during transcription.
 - D. They are responsible for chromosome segregation/decatenation.
 - E. They are multidomain proteins undergoing large conformational changes during catalysis.

二、簡答題（共 46 分，共 9 題）

8. Please briefly describe what the end-replication problem is (2%), what is the consequence if it is not properly solved? (1 point) and how eukaryotic cells deal with it (2%)?
9. Please briefly describe how histone modification (3%) and chromatin remodeling (2%) contribute to DNA repair in eukaryotic cells?
10. Mitochondrial DNA (mtDNA) faces more challenges from ROS stress comparing to nucleus genome. To fight against the stress, mitochondria possess an efficient base excision repair (BER) mechanism to deal with ROS-caused DNA damages. Based on your knowledge of the pathway, try to name two key enzymes (full name in English) involving in it. (2%) In terms of the integrity of mtDNA, what consequence do you think would be caused by loss-of-function mutations in genes encoding BER enzymes? (3%)

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第 3 頁，共 3 頁

11. CRISPR/Cas technology is a powerful tool for making gene knock-out. This process involves Cas introducing DNA double-stranded break in targeting gene and a followed DNA repair mechanism carried out by cells. Based on your knowledge of cellular DNA repair mechanisms, which pathway is most likely following Cas's action and resulting in knock-out of the targeting gene? (2%) According to your answer, briefly explain why this pathway would result in gene knock-out? (3%)
12. Please describe the differences between replication of DNA and transcription of RNA? (3%)
13. Please describe what "capping" and "polyadenylation" in the mRNA mean in the following: (1) chemical structure, (2) mechanistic processes how they are generated, and (3) their major functions. (9%)
14. Please describe mechanistic reactions for splicing of exons. (5%)
15. Please describe how mature mRNA are transported from nucleus to cytosol. (3%)
16. Please describe the following terms: (1) enhancer, (2) attenuation, and (3) mediator. (6%)

四、問答題 (40 分，每題 10 分)

17. Please describe in detail the role and function of eukaryotic translation factors resemble to prokaryotic translation factors IF1, IF2, EF-Ts, EF-Tu, and RF1. (10%)
18. Please describe the post-translational modifications and quality control in the rough endoplasmic reticulum (rER). (10%)
19. Please describe in detail the bacterial SOS regulon (regulatory system) in DNA damage response. (10%)
20. Please describe the function/role of Xist (X chromosome inactivation specific transcript) and Tsix RNAs in X chromosome inactivation. (10%)